SOIL CONSERVATION

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COOPERATIVE EFFORTS LAUNCHED TO CONTROL EROSION ALONG HIGHWAYS

By T. B. Chambers[1]

In recognition of the seriousness of erosion along highways in all parts of the United States, Thomas H. MacDonald, Chief of the Bureau of Public Roads, recently proffered to the Soil Conservation Service the cooperation of his agency in the study of control methods. The suggestion was eagerly welcomed by Mr. Bennett, who at once named a committee to work out cooperative relationships between the two bureaus.

Whole Country Affected

The problem to be met lifts its head at almost every roadside. It is not confined to any one section of the country. The pictures accompanying this article are an indication of conditions to be found in widely separated localities. Any traveler sees rills and gullies busy filling highway ditches, clogging drainage structures, and otherwise damaging traffic lanes and adjacent lands. He observes roadside ditches eroding and developing into gullies destructive to roads they were designed to protect. He finds gullies resulting from berm ditches; unprotected drainage channels carrying concentrated water that erodes farm lands and sometimes creates overfall gullies to menace highways; gullies cutting headward above highways that could have been forestalled by protection to banks or correction to structures where the overfall developed.

Officials responsible for construction and maintenance of highways have a definite responsibility for correcting such conditions as these. As a general rule they recognize this responsibility and on occasions they have made attempts to shoulder it. The conditions under which they work do, however, require that a maximum number of miles of roads be constructed with the available funds. Because of this, it often happens that features tending toward efficient erosion control and more economical maintenance are omitted from the original construction plans. When highway officials become convinced that there are erosion-control practices which have been tested and proved satisfactory for their particular conditions, and which if put into use will reduce the annual cost of highway maintenance, will make highways more useful, and will at the same time contribute toward roadside beautification, they are pretty likely to embrace them wholeheartedly.

Involves Soil Conservation

The soil conservationist has a very definite responsibility in developing and demonstrating erosion-control practices adaptable to highway use. He is interested primarily in erosion control as such and

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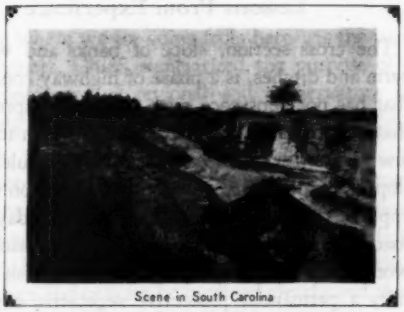
Highway culvert washed out. One mile west of Hokah, Minn.

is not subjected to the multiplicity of problems confronting many highway officials. From his experience he should have acquired a good knowledge of what measures will be most successful. He approaches the problem not from the single standpoint of soils or engineering, agronomy or forestry, but comprehensively, in an effort to correlate structures, vegetation, soil type, and climate. He is probably more interested in soil conservation than any other group—and erosion control along highways is assuredly a phase of soil conservation. Unfortunately, experience and knowledge are limited to such extent that demonstration blends with experimentation. Instead of recommending practices to be followed over large sections, he must cautiously design his works on small experimental scales. It stands to reason that the demonstrations should be numerous and varied, covering only short sections of roads, but containing as many problems as possible, to the end that whatever solutions are derived will be widely applicable.

Roadside erosion control invites cooperation. The Soil Conservation Service has the personnel and facilities for conducting demonstrations within the limits of its watershed projects, or within the E. C. W. camp work areas. Cooperation of highway officials can generally be obtained; in many cases they are eager that the work be carried on. The National Research Council through the Highway Research Board has recognized this problem as being of national importance, and is at present cooperating with the Bureau of Public Roads, various State highway departments, the Tennessee Valley Authority, and the Soil Conservation Service, "to study methods and demonstrate practices, materials, structures, and plants best adapted for the prevention of erosion along highways under varying conditions of cross-section, soil type, and climate."

In the cooperative scheme the Highway Research Board will act as a clearing house for assembling, analyzing, compiling, and disseminating information secured from the demonstrations.

Other agencies, including garden clubs, civic leaders, and some State highway departments, are interested in roadside beautification. Fortunately, beautification of highways by planting lends itself to



Scene in South Carolina

This gully is very active, advancing towards a county public road and also eating back into the field. This is the result of water entering from the road. The banks have since been sloped and vegetation planted.

Scene in South Carolina

This stream had a clearance of about 12 feet when the bridge was constructed some 14 years ago. At the present time silting has ruined 4 acres of good bottom land and reduced the clearance to about 18 inches.

Scene in Wisconsin

Raw road cut erosion, formed by water drainage from above.

Scene in South Carolina

Active roadside gully formed in old roadbed. Note new location of roadbed. This is the way many gullies in the Piedmont region are formed.

Scene in Missouri

Small gully as result of highway water running through. This was timothy sod, with no gully and was plowed in the spring. This gully washed by the middle of June.

Prepared by Soil Conservation Service Drafting Unit

erosion control and, conversely, erosion control lends itself to beautification. The landscape architect will be a motivating force in the work.

Land Owners Must Help

Owners of adjoining lands must cooperate, also, if best results are to be obtained. It will often be necessary to obtain wider rights-of-way to provide sufficient space for bank sloping and rounding operations. In a great many locations it will be necessary to extend control features some distance from the right-of-way, in order that gullies may be treated or drainage channels protected. Some protection to watersheds above the highway may be necessary to prevent damage to highways from excess run-off or deposits of silt.

The immediate objective will be protection and beautification of existing highways by structural and vegetative methods of erosion control. Such methods will demonstrate proper cross section with relation to soil type, climate, and vegetation; methods of protecting roadside ditches and treatment of cross-drainage channels above and below highways.

Lessons From Experience

The cross section, slope of banks and widths of berm and ditches, is a phase of highway construction that has not kept pace with the great improvements that have been made in pavement design in the last few years. In many locations the old set rules of 1 to 1 slopes on cut banks, and 1½ to 1 slopes on fill banks apply at the present time as in the early days of railroad construction. Experience in erosion-control work has indicated that in order to establish economically a permanent protective vegetative cover, most soils must be shaped to a flatter slope. Satisfactory slopes may vary with soil types and often with the same soil in different locations.

Protection of roadside ditches will most often be by mechanical methods on steep grades where high

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Road construction sometimes initiates gullies. Here's a gully in Colorado that is nearly 30 feet deep, becoming steadily shallower toward its source. The culvert in the foreground is 3 feet in diameter, 18 to 20 feet from the bottom of the gully.

REGIONAL CONSERVATORS SPEND BUSY WEEK IN WASHINGTON

"To see where we are going from here", is the way H. H. Bennett, Chief, summarized the purpose of a week's conference of regional soil conservators at its opening in Washington, Monday morning, February 24.

With congressional budget hearings recent history and the national legislative body putting into final order the new Soil Conservation and Domestic Allotment Act, it was deemed of primary importance that Bureau plans and policies be outlined clearly and that national headquarters avail itself of the experience and viewpoint of its 11 principal field lieutenants.

Many Topics Discussed

Every important phase of Bureau activity shuttled back and forth in review at the long council table around which were gathered Dr. T. S. Buie, H. G. Calkins, H. J. Clemmer, J. S. Cutler, H. H. Finnell, L. P. Merrill, Dr. A. L. Patrick, H. E. Reddick, W. A. Rockie, R. E. Uhland, and Dr. N. E. Winters.

Division chiefs, section heads, and specialists joined in the discussions.

Guest Speakers

Speakers included Henry C. Wallace, Secretary of Agriculture; M. L. Wilson, Assistant Secretary of Agriculture; James T. Jardine, Chief of the Office of Experiment Stations; Dr. W. W. Stockberger, Director of the Office of Personnel, and P. L. Gladmon, Chief of the Division of Appointments, Department of Agriculture; F. A. Silcox, Chief of the Forest Service; and Robert Fechner, Director of Emergency Conservation Work.

Attention focussed recurrently on the functions and relationships of regional conservator, State coordinator, and project manager. With many questions yet remaining to be decided by local exigencies, in general it may be said that the conservator will constitute a part of the Washington office, taking from the latter much of its load of responsibility. He will be responsible for inspection, for interpreting Bureau policy in the field, for keeping operations on a high standard, for acting in numerous fiscal matters, and for clearing ideas.

The State coordinator will be the actual State administrative officer, charged with the general direction of project operations. He will be responsible for the development of plans and programs in cooperation with the State advisory committee, and for coordination of the work with cooperative agencies. He will continue as a member of the conservator's staff, but may report on certain matters direct to Washington.

"Primarily, the State coordinator is there to get the job done", said Mr. Bennett, in stressing the importance of having in the position a man of strong executive ability and high standing in the State.

OUTLINE OF DISCUSSIONS[1]

Monday
General organization and functions.

Tuesday
Business administration.
Personnel and training.

Wednesday
Cooperative relations and planning.
Information. Photography.

Thursday
Research in soil conservation.
E. C. W. activities.

Friday
Projects and project operations.

Saturday
P. W. A. activities.

[1] Partial only. This outline does not take into consideration subtopics introduced, committee sessions, and informal group conferences.

Smooth Operation Assured

With this concept of set-up as a starting point, the conferees launched into a full schedule of day and night sessions before which passed in review a long parade of problems in organization, business administration, personnel and training, cooperative relations and planning, informational work, research, E. C. W. and P. W. A. activities, project operations, and fiscal matters. Only a few of the high points may be touched upon in this issue of SOIL CONSERVATION. In view of both the com-

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GLEANED FROM MEETING OF REGIONAL CONSERVATORS

One of the keynotes of the conference was the thought expressed by Dr. Lowdermilk, and further developed by Dr. Youngblood, to the effect that our problems are really problems of the Department of Agriculture; that all available facilities and talent of the various bureaus should be utilized to the fullest advantage, and that no single bureau could lay exclusive claim to the results accruing from such coordinated effort.

The readjustment of old projects to a maintenance basis under terms of the new budget was a topic of discussion. Under such readjustment, extension of works to new farms will be curtailed.

To tell the public the facts about activities of its Soil Conservation Service and to tell farmers how they may adapt the methods of erosion control demonstrated by the Bureau is the function of the information staff—not to publicize or propagandize. In making this clear to conservators, George Barnes, head of Information, emphasized the importance of having information workers not only familiar with established channels, but trained in propriety, accuracy, and Service policy and program.

It is highly important that vouchers be audited in the field before being submitted for payment, inasmuch as the certifying officer is personally liable for any overpayment.

When you talk about soil conservation you find that it is almost synonymous with agriculture—Dr. James T. Jardine.

It is necessary to establish terminal facilities so that research studies will come to an end at a definite time rather than continue forever.—Dr. W. C. Lowdermilk.

So far as the details of research are concerned, these are matters of experimental technique, to be worked out by the Service and the States—Dr. James T. Jardine.

A revision of the basic form of cooperative agreement, to permit greater flexibility and ease of adaptation to conditions in the several regions, will result from the efforts of a special committee appointed for the purpose.

Our C. C. C. work was originally started to demonstrate what can be done to conserve trees, soils, wildlife, etc., rather than actually to do the work on an extensive scale.—Robert Fechner.

It is intended that the State advisory committee be limited to not more than five members; usually it will be composed of three: the State director of extension, the State director of experiment station, and the State coordinator. In some instances it will include the dean of agriculture, and, in a few States, it takes in a State forester, a State engineer, or a State commissioner of agriculture. It should be held to representation of agencies or institutions that are directly responsible for administration of programs or projects in fields closely related to conservation.—Dillon S. Myer.

Mr. Myer described the functions of the State advisory committee as being—

To assist in selection of project and camp areas and in policies relating to abandonment of projects or camps.

To assist in development of subject matter, principles, and working plans which are basic for all projects within the State.

To assist in development of cooperative research plans and programs.

To assist in development of cooperative educational plans and procedure.

To assist in formulation of legislation or policies relating to legislation within the State, or to soil conservation districts or associations, or other soil conservation work.

Subcommittees composed of subject-matter specialists in college, working in cooperation with Soil Conservation personnel, are urgently recommended to assist the advisory committee and the Service in development of work plans, project plans, subject-matter principles, and other technical problems and policies.

The advisory committee, says Mr. Myer, should be consulted regarding employment of major personnel, especially State coordinators and major technical men to be assigned to work within the State.

PROGRESSIVE TRAINING PLANNED FOR S. C. S. WORKERS

Within the next few weeks training centers in each of the 11 regions will begin the task of transforming technicians into soil conservationists. Young men whose chief interests heretofore have reposed in agronomy or engineering, forestry or wildlife management, grasses or tractors or test tubes, will be given an opportunity to broaden their outlook, adjust their perspective and prove their usefulness in Soil Conservation Service jobs.

School doors will again swing wide, under a nation-wide program of instruction courses for field staffs announced by Dr. Roy W. Kelly, Chief of Personnel and Training. Studies will be conducted on an intensive scale, supervised by regional personnel officers and training directors, with lectures by specialists, and laboratory work in the form of actual project operations. June 1st has been set as the "dead line" for classes to be underway.

Getting Ready

In Washington slides, charts and other materials are being prepared which will furnish a panoramic view of erosion and its control throughout the country. In the several regions material is being assembled covering the special practices prevailing therein. Each training center will be provided with a carefully selected reference library.

"Regional conservators attending the recent conference in Washington were unanimous in attaching high value to the trainee courses of last summer", says Dr. Kelly. "As a result of the training offered then, there have been many promotions to responsible positions in the field organization. The program now being undertaken comes as a natural development of our explorations of last summer and is in part a result of the round-table discussions of a committee of conservators appointed during the conference."

Training Centers

The training program contemplates early designation of one or two training centers in each region. To these centers will be brought 20 or more picked employees at a time. Appointments will be made from the ranks of specialists in agronomy and range management, soils, agricultural engineering, erosion-control practices, forestry management, and wildlife management.

The class members will be assigned to regular posts of duty on the training-center project where each can do a full day's work in connection with regular field activities, and in some instances will be temporarily replaced at their home stations by transfers of other workers.

Classes will be composed of technical men, mostly of professional or subprofessional grades.

First to be given attention will usually be recently appointed technical employees, who will be put through a 3- to 5-week period of classroom instruction and field work.

Next on the calendar will be 3 months of systematic instruction for students obtained by the Service from civil-service lists in Washington. This will be followed by immediate assignment to active, productive field duty. Including the time taken for the training course, there will be a 6 months' probationary period, upon the successful completion of which will come promotion to positions for which fitness has been proved.

Finally, selections will be made from among the older technical employees, who will be brought together for a week or less of group instruction.

Seminars Probable

Dr. Kelly states that immediately following the completion of the 3 to 5 weeks of instruction for recent technical employees, numerous weekly or biweekly seminars will be organized in which all technical employees will be invited to participate.

The objectives of the training program for students are explained in some detail by Dr. Kelly, as follows:

First, to give to the students a general knowledge of the origin, development, purpose, organization, personnel, and procedure of the Soil Conservation Service. Without such an understanding the employee will be handicapped in many ways, and will never acquire a proper perspective of the organization and his own work. He will lack the general knowledge which is necessary to make him efficient, loyal, and enthusiastic.

Second, to carry on the general or orientation study into the various specialized fields, so that the employee may realize that soil conservation is an organized effort in which are coordinated the efforts of agronomist, engineer, forester, nurseryman, soils expert, and wildlife worker. He will learn by actual field contact how each department contributes in balanced proportion to effective accomplishment. He will become "Service conscious."

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GETTING THE FACTS ON STREAM DAMAGE

At the conference of regional conservators it was brought out that the sedimentation and hydraulic studies concern the far-reaching effects of soil erosion after debris leaves the cultivated uplands and, traveling by way of local drainage, finds its way into major streams.

Accelerated erosion resulting from man's use of the land resources causes this debris to enter the streams in such quantities that in many cases the streams are transporting this load to their full capacity and must continue to do so until they can lay down their burden, either in a lower part of stream bed, over bank on fertile bottom land, in some reservoir, or finally carry it out to sea.

The damage caused by this debris is interfering with navigation, causing floods to rise higher in the valleys, rendering highly fertile land unproductive, and depleting the storage capacity of reservoirs. The amount of this damage cannot even be closely approximated with the present state of knowledge on the subject, but the investments involved must run into billions of dollars.

The problem is being attacked along four main lines.

1. A nation-wide investigation on storage reservoirs, whether for power, irrigation, or water supply, is being made to provide an accurate record of the storage depletion and its effects upon the utility and longevity of the water supply. Information thus gathered will be of great value in determining future usefulness of each reservoir; provide the data for the prediction of depletion in future designs of similar structures, and form the basis for development of methods for temporary reduction of silting rate until widespread erosion control methods can be instituted.

2. Investigations of conditions and processes of sedimentation in stream channels and valleys are being inaugurated. Such studies are of vital importance to the conservation of fertile valley lands from excessive sedimentation and also to the preservation of stream navigability and the reduction of flood hazards.

3. Factors of bedload transportation in natural streams will be studied by direct measurement with new-type installations to be placed at selected sites on various streams in differing regions of the country, for the purpose of obtaining for the first time accurate knowledge of the total erosive and transporting power of large streams under present conditions.

4. Hydraulic laboratory investigations will include studies of factors affecting the energetics of debris-laden water, the wear of debris in the course of stream transportation, specific field construction problems, development of new erosion- and flowage-control practices and instruments for their measurement, and experimental application of results to full-scale engineering problems of gully and arroyo control in the field. These laboratory studies will be made with particular reference to erosion by larger streams, development of arroyos and like problems distinct from erosion studies on experimental plots and controlled watersheds.

TRAINING PLANNED

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Third, to provide job training in the specialized work for which the student enrolled. During this period of specialized work those in charge can discover the potential value of the new employee in his chosen field.

Fourth, to absorb the new employee into his permanent job on a probationary basis. During the entire probationary period he will be considered not only under observation but under instruction. If during the probationary period he lives up to the expectations of his superior he becomes eligible for permanent appointment and is then considered a regular employee fully qualified to proceed under his own initiative.

During the first year of service, new employees who come in as students will pass through four periods, the first three of which will constitute their training period, and the fourth of which will round out their 12 months' probation. As the end of the first week of classwork, the students will be divided into four, five, or six groups, according to their professional classification. Each group will be routed through a series of five stations on the training-center project or a neighboring project which will give practical training in soils, agronomy, engineering, etc., corresponding to the groups into which the class has been divided. One week will be spent at each station, and at the end of the period of station work each group will find itself assigned to the station representing its own professional classification. All groups will arrive at their own professional stations simultaneously.

The next 6 weeks will be given over to intensive specialized training, during which studies rather than production will have right-of-way.

It is the intention of Dr. Kelly and his collaborators that the entire training program shall be flexible and readily adaptable to local conditions.

RESEARCH IN THE ECONOMIC AND RURAL LIFE ASPECTS OF SOIL CONSERVATION

By Walter J. Roth[1]

Author's Note.—The following article was prepared in answer to numerous inquiries concerning the functions of the newly organized division of research in the economic and rural life aspects of soil conservation and its relations to other parts of the Service.

People themselves, their environment, their farming philosophies, their business and community relationships, color the foreground of the soil conservation picture. If our understanding of erosion and its control is to be in proper perspective, we must give weight to the economic and social factors. Excellent facilities already exist in the Department of Agriculture, as a basis for the specialized studies we contemplate, and this paper sketches roughly the lines of this phase of our research program.

In accordance with the principles set forth in the Secretary's memorandum of June 6, 1935, and the interbureau committee report of June 5, 1935, suggesting ways and means whereby all branches of the Department of Agriculture and the State agricultural experiment stations may participate in a comprehensive program of soil conservation research, a memorandum of understanding has been entered into between the Bureau of Agricultural Economics and the Soil Conservation Service. This memorandum assures the Soil Conservation Service of the leadership and experience of the Bureau of Agricultural Economics in research upon the economic and rural life aspects of its work. The objective is to provide sound economic and social research, as a basis for the development of policy and program.

The Memorandum of Understanding

In addition to recognizing the Bureau of Agricultural Economics as the agency directly charged with conducting research in the economic and rural life aspects of agriculture, and setting forth the need of such research by the Soil Conservation Service, the memorandum states that the Soil Conservation Service shall provide for such economic and rural life research as may be required in cooperation with the Bureau of Agricultural Economics.

[1] Dr. Roth is liaison officer and head of the division of research in the economic and rural life aspects of soil conservation.

The memorandum further provides that specialists approved by the Bureau of Agricultural Economics will be employed by the Soil Conservation Service to conduct, under the direction of a liaison officer, the essential research in the economic and social aspects of soil conservation. While this personnel is administratively responsible to the Soil Conservation Service, the Bureau of Agricultural Economics retains the authority for approval of projects, supervision of procedure, interpretation of data, and validity of conclusions. To the greatest extent possible, all such research activities of the Soil Conservation Service will be coordinated with the other research activities of the Bureau of Agricultural Economics.

One of the paragraphs specifying the activities of the newly developed economic research division is worthy of quotation:

> (e) The Soil Conservation Service may make economic surveys of farms in order to secure information for the conduct of its soil conservation operations, but will engage in no independent economic research. Such surveys in the future shall be organized so as to furnish information for the economic and rural life research. For this purpose the liaison officer shall approve all proposed survey schedules and the procedure for collection of the information. Workers of the Division of Conservation Operations who have participated in the conduct of these surveys of farms may be assigned to the economic research staff for the purpose of assisting in the research analysis when, by mutual consent, it is deemed of value to do so.

The foregoing statement means simply this: The Soil Conservation Service, in cooperation with and under the guidance of the Bureau of Agricultural Economics, will conduct research in the economic and social aspects of soil conservation, through the medium of the cooperative relations now in existence between the Bureau of Agricultural Economics and the State agricultural experiment stations, where such cooperative effort is mutually acceptable.

Cooperation with Experiment Stations

The Bureau of Agricultural Economics has had much valuable experience in the development and conduct of cooperative projects in all the States. This experience includes projects which involve a combined attack by State and Bureau workers on a multitude of problems. These are especially well exemplified by those in the organization and operation

of farms and related topics conducted by the Division of Farm Management. An outstanding example of such constructive cooperation was the conduct, under the guidance of the Division of Farm Management, of a significant research project in the summer of 1935. In cooperation with the A. A. A. and the 48 State agricultural experiment stations, the essential information relative to the suggested adjustments in the agriculture of the States was synthesized into a major statement for the agriculture of the Nation. This master project was continued in the autumn and winter of 1935–36 for further refinement and for verification of the initial judgments.

It was felt that the many worth-while contacts which have made such cooperation possible could be expanded to include the proposed research in the economics of soil conservation, much of which would be akin to the regular activities of the Division of Farm Management of the Bureau of Agricultural Economics. In furtherence of this idea, Farm Management furnished a member of its staff to serve as liaison officer between the Soil Conservation Service and the Bureau of Agricultural Economics, and to head the new research division.

With the plan now complete, administrative details are rapidly being worked out and proposals for a cooperative attack upon the economic and rural life problems incident to soil conservation will soon be ready for submission to the State agricultural experiment stations.

Cooperation with Division of Operations

Cooperation will be forthcoming from the Division of Operations of the Soil Conservation Service. Realizing early the need of research of this character, this division instituted a number of studies, the character of which permits of their being classed as economic research. According to the memorandum of understanding, these studies will be absorbed by the newly organized economic research unit. Because of the obvious value of such studies to the Division of Operations and because the members of the operations staff can make a major contribution to the collection, summarization, and analysis of economic and social data, the memorandum of understanding has provided that members of the Division of Operations may be assigned to active participation in these economic studies. Thus, instead of absorbing these studies, as such, the research division will function cooperatively with the operations division, and both, under the guidance of the Bureau of Agricultural Economics, will work toward a single purpose.

While cooperation between the research and operations divisions is in no sense rigidly fixed or mandatory, it does offer an opportunity to accomplish a larger portion of the purposes envisioned in the program for soil conservation than would otherwise be possible. The budget available for economic and social research will effect larger results by such cooperative effort. The details of this intra-bureau relationship will of necessity be a matter of arrangement with each regional conservator and finally with each State coordinator and project manager. In regions, States, and project areas where adequate cooperative assistance is available from the Division of Operations, the attack upon the problems will be proportionately larger.

Joint Effort Helpful

This joint effort will prove mutually beneficial. The data can be collected by a personnel thoroughly familiar with the farms being studied and benefitting from the guidance of trained research specialists. The summarization and analyses of the data, also participated in by representatives of the Division of Operations, will offer a maximum opportunity to produce valid conclusions. Under such a joint effort, many soil conservation problems will receive immediate as well as long-range solution.

In final analysis, all activities of the Soil Conservation Service may be challenged with the query: Are they economically and socially justifiable? Will they yield a dividend not only to the farmer but to society as well? In short, Will they pay?

It is a truism that the benefits of the observations developed in the operations activities will contribute materially to the interpretation made by the trained analyst. The point of view of the latter will likewise sharpen the observations of the workers more definitely confined to operations. The active cooperation of the operations staff with the research staff of the Soil Conservation Service, and of both with the specialists in the agricultural experiment stations, will mean a greater degree of usefulness for the research findings than if these were developed solely by the research staff.

As previously said, the objective is to provide sound economic and social research for the activities of the Soil Conservation Service.

Simply stated, such studies will be concerned with a contrast of the economic and social effects of uncon-

trolled and progressive erosion and soil depletion on the one hand, and the economic and social effects of soil-conservation measures on the other.

This means:

1. A study of economic and social conditions before the installation of erosion-control measures;

2. A forward-looking estimate of the economic and social effects likely to result from the inauguration of a definitely planned program of erosion control;

3. Eventually a backward-looking evaluation of the economic and social effects which have resulted from the adoption of the recommended measures; and, finally,

4. Such additional studies as will ultimately provide the Soil Conservation Service with a sound economic and social evaluation of the problems involved in its activities.

These studies will be concerned with both individual farms and with groups of farms. Through a process of extension of the findings, they will in time have an important bearing in planning the soil-conservation program of the entire Nation.

Out of these economic studies will come answers to many questions, such as the effect of the inauguration of soil-conservation measures upon farm practices, upon the organization and operation of the farm, upon farm income, and, finally, upon the farm-family living. Out of the studies will come evidence of the economic and social effects of erosion control upon groups of farms, communities, counties, or States and, indeed, upon the entire economic and social structure.

This is the proper field of inquiry. We believe that it will enable the division of research in the economic and rural-life aspects of soil conservation, in cooperation with the Bureau of Agricultural Economics and the State agricultural-experiment stations, to serve the Soil Conservation Service in the capacity envisioned—that of providing a sound, economic, and social evaluation of all its activities.

EROSION ALONG HIGHWAYS

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velocities cannot be prevented. On flatter grades wide, shallow, low-velocity ditches may be protected by vegetation. Types of vegetation adaptable to the soil and climate and its ability to prevent scour under various velocities must be tested and demonstrated. The cost of widening cuts to provide additional ditch width will often be prohibitive and mechanical control in the ditches will be necessary where otherwise less expensive vegetative control would have sufficed.

Realize Responsibility

Protection of erosion in cross-drainage channels has not always been considered a responsibility of the highway official unless the highway itself was damaged. The fact that concentration of waters by the highway often damages lands below the road or the fact that concentrated waters are discharged across lands at new locations, does, however, indicate the need of highway authorities giving greater attention to erosion. Control of overfall gullies cutting headward above highways caused by overfall developed at cut banks, drainage structures, or other places for which the highway is accountable, is also within the sphere of those engaged in highway construction and maintenance.

The ultimate objective should contemplate the adoption of effective erosion-control measures on existing highways and inclusion of them in plans for future highways. In fact, by far the greatest good can be accomplished with the least expenditure by providing for erosion control and roadside beautification at the time the highway is first planned. A great many factors should be considered by the locater and designer that have not always been given proper attention in the past. Location of highways with consideration for future erosion control and beautification would result ordinarily in improvements of other kinds. Maintenance would surely be lessened by reduction in scouring and silting. There would be fewer slides, falling rocks, washouts, caged fills, and less silt would be deposited on adjoining lands. The locating engineer, instead of attempting only to fit the required alinement and gradients to existing topography in the most economical manner possible, so far as initial costs are concerned, would give some thought to such factors as soils, soil moisture, underground drainage and seepage, exposure, general topography as it relates to drainage, possibilities of drainage water entering and leaving the roadway without damage to the highway or adjoining lands, and probabilities of slumps and slides. To secure really effective erosion control for future highways, the type of roadside should receive full consideration.

New contour furrowing plow developed by soil conservation technicians at C. C. C. camp, Springfield, Colo.

PROTECTING COLORADO'S RANGE LANDS

By J. G. Lindley[1]

Colorado is a State of high plains and redbeds, of Douglas fir and Englemann spruce, of Russian thistle and grama. Its topography ranges from the towering Sawatch Mountains to the comparatively low Arkansas River Basin.

Agricultural regions within the State necessarily present a similar variety. Colorado leads in the production of sugar beets. It stands high in cantaloups, fruit, potatoes, and barley. And—here's where Colorado soil conservationists find a real problem—the 1930 census gives a total of 19,338,377 acres of pasture land, much of which is rapidly becoming depleted by overgrazing and subsequent wind and water erosion.

A Difficult Situation

When the Soil Conservation Service inaugurated its erosion-control program for the State in March, 1935, overgrazing and a succession of dry years had reduced vegetation on thousands of acres of pasture lands to a sparse stand of grass and stunted Russian thistles. Slopes range from 1 to 7 percent, and the dusty condition of the surface made water penetration negligible. Run-off during the torrential rains, which are characteristic of this region, amounted to as much as 90 percent. Sheet erosion, gully cutting, and destructive flood-water concentration were the result.

The soil-conservation demonstration work was augmented by the establishment of nine Civilian Conservation Corps camps. Two of these were transferred from the Forest Service—the one near Colorado Springs where an effort was being made to control floods coming into the city down Shooks Run, and the one at Castle Rock where the project embraced several of the main tributaries of troublesome Cheery Creek. Seven new C. C. C. camps under the expanded program were distributed in eastern Colorado from Box Elder Creek in the redbeds to Springfield, well within the northern limits of the dust bowl.

Previous experiments had shown that effective control might be achieved only by holding the water on the ground where it fell. This strategy results in retarding concentration, stopping sheet and gully erosion, furnishing moisture to reestablish a vegetative cover, and eventually raising the water table.

Contour Ditches Built

A. E. McClymonds, regional director, since designated State coordinator, found the answer to those

[1] The author of this article is head of E. C. W. operations of the Soil Conservation Service.

objectives in contour ditches large enough and close enough together to retain all of the water which might fall during any one storm. Insufficient precipitation statistics were available for computation of the necessary cross-section sizes and contour intervals. Using an arbitrary basis of 3 inches of rain as the maximum, contour furrows were constructed 8 inches deep, 10 inches wide at the bottom, and 20 inches wide at the surface. These furrows were constructed at 2-foot vertical intervals, the dirt from each furrow being used to form a dike on the lower side. The upper toe of the dike was set back 6 inches from the lower rim of the ditch so that the shoulder formed a berm to prevent the sloping earth of the dike from falling into the ditch. Cross-checks are built every 50 feet along the contour ditches.

During the first experimental work, a plow furrow was made on the contour and enrollee hand labor followed with shovels and mattocks. This method was too slow, and camp superintendents were encouraged to try out different plows and ideas to speed the task.

As a result of their ingenuity, two plows were developed, which are different from anything used before and which are admirably suited to do a finished job in one operation. C. C. C. enrollee labor is now used only to install the cross-checks and to do a very small amount of finishing work in the furrows and dikes. By this method it is possible to turn out 6 to 8 miles of contour furrows per day, per machine, and it is believed one of the problems of protecting Colorado's range lands has been solved.

Efficiency Reported

Do the contour furrows hold the water and conserve the soil? Colorado's C. C. C. camps report that they do. The Pueblo camp received two heavy cloudbursts during the latter part of August. In the first a little less than 2 inches of rain fell in 45 minutes; in the second, 2 inches of rain fell in 60 minutes.

Two interesting results showed up following the last big rainfall. Sixty hours after the storm it was found that in the contour furrows the moisture had penetrated to a depth of 41 inches. Half-way between the furrows, moisture had penetrated to a depth of 24 inches, whereas on land located in the same field and on the same slope, but upon which contour furrows had not yet been constructed, the moisture had penetrated to a depth of only 8 inches. The other notable result of the two storms was the rapid growth of grass during September on the land which had been contour furrowed. There was a decided difference in the brightness and growth of grass on the land which had been treated, compared with adjacent untreated fields. By October, the grass along the upper sides of the contour furrows was in bloom and starting to form seed—the only grass seed formed on any land in that part of the Pueblo area during the year.

Good Results Attained

This report from the Pueblo camp is not an isolated one. Each C. C. C. camp reported similar success. Only in a few instances did a dyke break, and then, contrary to expectations, it did not result in progressive failure down through the lower contours. For the first time known, all of the water was held on the ground. Not a drop ran away to the gullies, and for 2 days glistening parallel ribbons of water stretched over the undulating hills, slowly penetrating the thirsty ground.

But contour furrowing is not the only C. C. C. erosion-control activity in Colorado. Trees are being planted to combat the menace of wind erosion. Check dams are protecting both agricultural and grazing lands from gullies and from floods. Seed collection, riprapping, stream-bed improvement, bank sloping—these are all units in the balanced soil and water-conservation program now going forward under full steam.

Many problems still confront the Soil Conservation Service and its nine C. C. C. camps in the State, among them the exclusion of stock from range lands while revegetation is under way, and proper methods of reseeding. An entirely gratifying result of the program is the reaction of the farmer. Colorado farmers are becoming convinced that many of their worries will be solved under this new land treatment.

REGIONAL CONSERVATORS

(Continued from page 5)

prehensive and intensive study of objectives and of *modus operandi*, conservators are assured of increased smoothness and sureness of practice and procedure in their several regions henceforth. This conference, the first of its kind, will be followed by others—probably at 4-month intervals through the year.

As the conference came to a close, the new Soil Conservation and Domestic Allotment Act became law and Secretary Wallace announced meetings for Chicago, Memphis, New York, and Salt Lake City to consider its implications. Conservators, in many cases, went direct to these meetings from Washington, to lend any assistance possible in making the new program a success.

A NEW MACHINE FOR MAKING CONTOUR FURROWS

By C. A. Logan

EDITOR'S NOTE.—This article presents more detailed information concerning the machine described on page 16 of the October 1935 number of this magazine.

The need for a less expensive and better method of contour furrowing pastures in the Limestone Creek demonstrational area in Kansas was the incentive for developing a new machine.

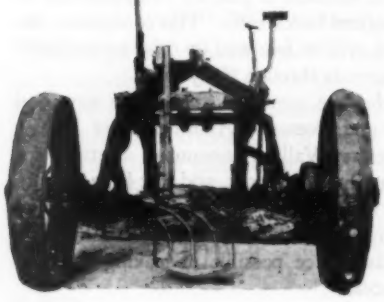
The idea of placing a sod strip in an unbroken ribbon on the lower side of a furrow, with the grass side up, looked so promising that when hand labor proved impracticable a determined effort was made to build a machine that would do the job.

The one-way and two-way machines shown in the illustrations were designed and built by A. J. McCleery, H. L. Gamble, and myself.

The first machine was made from a worn-out two-bottom plow; an old road planer blade; ⅝-inch round mild steel rods, and 1¼- by 1¼-inch angle iron. A satisfactory hitch, depth regulating lever, stripper blade and the proper curvature and length of rods had to be worked out by trial and error.

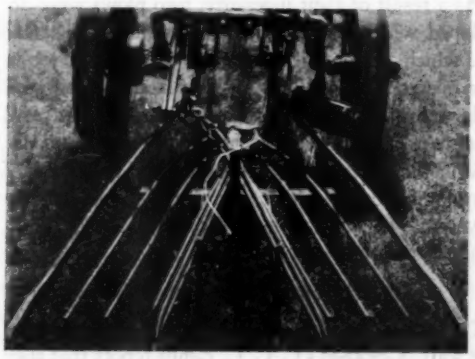
Occasional trouble was experienced when tough weeds and roots collected on the vertical cutting edges of the U-shaped blade. This condition was most noticeable in loose, moist soil and was largely overcome by sloping the vertical cutting edges forward at approximately 35°.

To obtain a good bond between the sod strip and the ground upon which it was placed a stripper blade was used to remove the grass and trash. To keep trash from clogging under the cutting edge the toe of this blade was adjusted to about three-fourths of an inch deep when the heel was just entering the ground.



Sod strip properly placed 3 to 4 inches below furrow wall.

Rear view of two-way contour furrowing machine. It may be reversed by pulling a pin and reversing center segment of rods.



The unit can be pulled by a 1½-ton truck but a two-plow tractor is preferable. By careful driving, horses or mules could be used.

The rapidity of travel affects the placing of the sod strip. A properly placed strip should be 3 to 4 inches below the furrow wall to lessen the possibility of breaking down the side wall and the narrow strip of grass left growing along the edge aids in making a water-resistant seal. When using power units of different speeds it is necessary to adjust the curvature of the delivery rods to secure proper placement of the strip.

(Continued on page 15)

CORN GIVES WAY TO DIVERSIFICATION

By R. E. Uhland

The one-crop system of farming which existed in the Big Creek area of Missouri up to the establishment of the Soil Conservation Service project there in October 1933 is rapidly giving way to crop rotations and diversification.

Corn had been considered king for many years and it was with reluctance that some of the farmers changed from all corn to less corn and a variety of other crops. On many farms this change should have been made many years ago, as soil losses have brought about a state of infertility which it will take years of planning and effort to restore to anything near their original productivity.

Our soils men have found that 50 to 75 percent of the surface soil is gone on more than half of this watershed. Along the interstream divides where Grundy was formerly wide and fertile it is now thinned a great deal and the strip along the ridge is much narrower. Comparing this condition with a soils map made 20 year ago reveals the startling change that has taken place. Depletion proceeded so gradually that people living on the soil hardly realized what was happening.

There are 1,042 farms in the 152,217 acres comprising the Big Creek Watershed. Most of them are now covered by cooperative agreements with the Soil Conservation Service. Many of the operators are going ahead with the program, under the guidance of the field men of the Service, quite on their own initiative. Recently a number of farmers asked that strip crops and contour crops be laid out on their farms, even though their original agreement did not include these measures. In most cases farmers asking to have strip cropping or contour farming added to their agreement live close to a neighbor who has one or both of these practices on his farm. They have observed the part strip crops or contour rows play in solving the problem of soil erosion, and also how easily they work with terraces.

Prior to starting the project, contour and strip cropping were practically unknown in this area. At first many farmers viewed the practice skeptically. Farmers of the region have always taken pride in making straight rows and many of them felt to run their rows on the contour would take all the pleasure out of their work. That this fear is being dispelled is shown by the fact that 4,238 acres will be newly strip cropped and 6,189 acres will be newly contour tilled. These practices are of course supplementary to the changes in cropping plans and terracing.

Probably the most remarkable change of all, however, is the general willingness on the part of owners and tenants to change from corn to a diversification and a crop-rotation system which will include a legume at least 1 year in 4. Crop rotations have been worked out for 46,386 acres of land; 12,699 acres of erosive land have been taken out of cultivation and seeded to permanent hay and pasture. Pasture management is being stressed for the entire area. In some cases this adoption of the recommended rotations and cultural practices may mean a slight reduction in income for the next year or two. Our farmers see the advantage of making a temporary sacrifice in favor of a good soil-building program.

NEW MACHINE

(Continued from page 14)

The two-way or reversible unit is desirable where the furrows are longer than 600 feet. One disadvantage of the two-way machine is the fact that the sod must be removed from the rods before the movable guide can be reversed. It is possible that in large-scale operation it would be more economical to have independent right and left units mounted on one frame.

Data from experimental plots on the Limestone Creek area show that the contour furrows increased the forage growth about 29 percent in 1935 and that the best horizontal spacing between furrows was from 16 to 20 feet. Furrows were 12 inches and from 4 to 6 inches deep. More experimental work is necessary to determine the best width and depth.

This method of treatment is particularly well adapted to buffalo sod pastures where the sod is sufficiently dense to form a continuous ribbon.

How a sod strip with a good seal impounds water.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A Contribution from the Soil Conservation Service Library

SAHARA, THE GREAT DESERT. By E. F. Gautier. Translated from the second French edition of Gautier's Le Sahara. Translation by Dorothy Ford Mayhew. 1935.

This is a book for the geographer and geologist, with copious notes regarding the author's researches and the results of his and other expeditions into that vast expanse of land which breaks all records as a planetary desert—the Sahara. Through part I, Gautier contrasts and differentiates between the steppes and the true desert. This appears to the reviewer to be an especially brilliant maneuver, separating and emphasizing as it does in the mind of the reader the vast, almost completely azoic belt which is the Sahara proper, from the Continent of Africa and the whole planet Earth, in preparation for the learned study of the geological and geographical structure and history which is the body of the book.

According to Gautier, there is a considerable amount of precise and conclusive data supporting the theory that at an age as remote as the Silurian the Sahara was already a desert. Some other writers, however, who have studied the desert, present evidence to the effect that, although arid, parts of the Sahara were grassed at the time camels came into the region, and that the Romans bought wine from coastal areas.

In the still unknown heart of the Great Desert, where the sedimentary deposits are concealed by the erg, a great deal of geological investigation must be done before the remote history of the region can be known. However, much work has been accomplished by the Algerian Geological Service in the northern region and on the Algerian steppes. There are found incrustations of alluvial secretions, layer upon layer, in Oligocene and Quaternary strata, containing fossils by which both their age and continental origin are established. It appears that, in the Triassic stage, Algeria was a composite of closed basins, with lagoons where salt and gypsum were deposited in extraordinary quantities. Likewise, the sandstone layers, laid down through different geologic ages, are similar in that they are all petrified, solidified ergs. From this it is concluded that, generally speaking, the Algerian climate changed little from the Silurian age to the glacial age when there was more humidity than at the present day.

It was in the glacial age that vast, complex valleys were cut, from the Atlas to the bend of the Niger, and in the French Sahara. Great rivers were there, and today their courses are easily distinguishable between great ergs and denuded rock mountains. These Quaternary rivers, terminating in closed basins or alluvial regions such as Lake Chad today, formed a communication route between the Mediterranean regions and the Sudan, as the Zambezi fauna fossils found in Saharan Quaternary deposits attest. The Carthagenian elephant, mentioned by ancient historians, is, indubitably, a relic of this residual fauna. It would be interesting to know what was the distribution of this elephant. Its existence suggests vegetation, and a decline of vegetation during the historical period. If such a decline, erosion should have been accelerated within the historical period, at least in parts of the Sahara.

The author's story of superficial circulation of Saharan water is extensive and detailed. Points that are of outstanding interest are: The subterranean infiltration of the Niger waters far out under the great Juf wasteland; "elbow capture" in the making today—where a Niger tributary captures a Shari tributary during flood seasons; the mysterious buried channel of the Shari. One cannot but wonder what will become of the vast underground reserve waters of the Chad Netherlands when, in an age to come, the Niger system completely conquers the Shari system. Will it be diminished gradually, poured into the Gulf of Guinea 2,000 miles to the west?

The triumph of the Nile in traversing the entire desert and finally reaching the sea, by way of the Quaternary Rift Valley, is unique in the known history of the desert rivers. Here is the one route by which the abundant waters from the great Abyssinian mountains are carried through the Sahara northward to the sea. The Saura system, however, originating in the high Algerian plateau, occasionally is flooded by terrific mountain-storm waters so that, rushing with tidal-wave force down the steep slopes, it carries an immense amount of water southward to the great dune land of the Algerian desert, there to end in an alluvial region, to seep through erg sand and join the subterranean system of the ancient Saura. Here, along the Saura, lie true oases, with palm groves and villages, and here with the onslaught of the yearly or biyearly floods, unwary travelers camping in the dry channels are sometimes drowned before they have any thought of rains or floods.

The study of progressive desiccation of the Sahara, as presented by Gautier, is extremely interesting. From well-authenticated historical data collected by various Tunisian department of agriculture scientists, and by the botanist, Lavauden, it appears that the Sahara, along its northern front was, as late as the fifth century B. C., associated with a civilized humanity. Archeological investigations prove that in the Terres Sialines region the Romans carried on extensive agricultural pursuits. In the same region today, under the direction of Bourde of the Tunisian department of agriculture, excellent olive crops are produced. This fact does not seem compatible with any real climatic deterioration since the Roman epoch. Possibly erosion was the cause of the rapid land desiccation between the Roman epoch and the present day—over use of the land and waste of the springs of water.

In his description and discussion of desert erosion cycles, Gautier is a little disappointing. If, as he sets forth, the words "wadi" (a desert watercourse ending in an alluvial region in a closed basin) and "pasturage" are interchangeable in the language of the nomads, must not there have been in the present geologic age, a period of accelerated erosion resulting from over use? In fact, in the author's air photograph of a dayа plateau, surface erosion is actually to be seen.

As to the Saharan oases, they have their life and being, not in the superficial or surface waters, but in the artesian waters which flow in great beds beneath the rocky foundational layers and are brought to the surface only through the occasional play of a fault or rift in the crust. Thus it is that the oases are small and few in number. Contrasted with these tiny fertile areas, are the vast completely arid regions called by the author "tanezroufta", the utterly old desert, the empty dead immensities where, according to the superstitious nomads, a jinn called Rul bursts into laughter and shouts from the dunes.

In striking contrast with this prehistoric and historic Sahara, Gautier has, in his conclusion, presented a vivid picture of North Africa's vast arid lands during the last 75 years of European occupation. This conclusion he calls "The New Sahara", and in it he tells of an open country already confronted by economic and industrial problems common to modern progress, yet showing an amazing advance and development in an incredibly short space of time. Modern transportation, the wireless telegraph, beacons as guides to motor as well as air travel, intensive cultivation of cotton and gum acacias and manufacture of gum arabic along the Nile, the opening of river routes from the Chad Basin, the establishment of fisheries at Port-Etienne with the European and Black African coastal markets, the suppression of the slave trade—all these Gautier regards as the beginning of a new and happy era for the Great Saharan Desert.

"Sahara, the Great Desert", is specially well assembled, with fine photographs, drawings, and maps by Paul Laune, a glossary of Saharan words and expressions, and complete index. There are bibliographies at the ends of all chapters.

U. S. GOVERNMENT PRINTING OFFICE: 1936.